PATENT SPECIFICATION 1,161,872

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in or relating to Shaft Furnaces.

We, STEETLEY DOLOMA (PROCESSING) LIMITED, a British Company, of Gateford Hill, Worksop, Nottinghamshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to shaft furnaces and in particular to a charging device for a shaft furnace. In such furnaces a granular material to be processed is fed to the top of the furnace and the processed material is removed from the bottom of the furnace. As a burden moves down through the furnace it is subjected to the effects of heat and a countercurrent gas flow. The heat may be produced by the burning of combustible material mixed with the burden or it may be produced by burning gas or oil in the furnace or by heating the gas flowing countercurrent to the burden before it enters the furnace.

Examples of such furnaces are blast furnaces for the production of iron and shaft kilns for burning lime, dolomite or magnesite.

In the blast furnace, the product is removed in the molten state and the burden is made up of a number of different materials which react together chemically in the furnace.

In the mixed feed dolomite kiln, the product is removed as a granular material and the burden is made up of coke and raw dolomite. The coke burns in the kiln and provides the heat which first decomposes the dolomite driving off carbon dioxide and then effects a sintering action to produce granules of doloma, which consists of the oxides of calcium and magnesium.

In a gas-fired kiln for burning magnesite, the product is removed as a granular material and the charge consists solely of a precursor of dead burned magnesia, such as the mineral magnesite or pellets of caustic magnesia.

The common feature in all furnaces of this kind is the charging of granular material as the burden and the presence of a countercurrent flow of gas up through the burden. In order to attain uniform working of the furnace it is important that the gas flow should, in general, match the flow of solids at all positions across the cross-section of the furnace. If the gas flow is concentrated near the wall of the furnace, for example, the processing of the burden will proceed at a greater rate near the wall than in the centre. This inhibits the efficient working of the furnace. For example, in the mixed feed dolomite kiln, the result is to overburn the material near the wall of the kiln and to lightly burn the material near the centre of the kiln thus producing a non-uniform product in which some granules are of good density while others are not dense enough.

In fact, the tendency of these furnaces is for a preponderant part of the gas flow to be concentrated near the wall of the furnace. The reason for this is that the wall, which is lined with refractory material, becomes uneven in use and impedes the downward flow of material close to it thus opening up gaps in the burden near the wall. The wall thus presents less resistance to gas flow than the closely packed burden nearer to centre of the furnace. In addition, the downward flow of material near the wall tends to be slower than the downward flow of material near the centre of the furnace and its "dwell time"

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is thus longer. Material near the kiln wall is thus processed more rapidly and for a longer time.

To overcome this effect, arrangements have been proposed which have the effect of charging larger granules of material to the centre of the furnace and smaller granules to the part of the furnace nearer the wall. This has the result of reducing the resistance to flow of gas of the central part of the burden while increasing the resistance of the part of the burden near the wall of the kiln and thus tends to counteract the effect produced by the wall friction.

On arrangement used in blast furnaces, for example, is to charge the whole of the burden to the perimeter of the furnace, leaving a hollow at the centre. When the burden is charged, the larger granules in the burden tend to roll down into the hollow and thus congregate at the centre of the furnace. This method provides only a very rough means of control. A more satisfactory method but a very expensive one is to provide a charging tub which is filled with a charge for the furnace, the different sized granules being arranged in the tub according to the pattern in which it is desired to distribute them in the furnace. The tub is then transported to the top of the furnace, the bottom of the tub is opened or removed and the charge is dropped on to the top of the burden.

We have now surprisingly discovered that sufficiently accurate charge distributions to give the required control over gas flow within shaft furnaces can be obtained by means of a charging device having an inner charging chute and one or more outer charging chutes around it. Material of different grain sizes can then be supplied to the various chutes to produce a distribution such that the material within given radial distances from the centre of the kiln will consist mainly of granules within a given range of sizes.

According to the present invention there is provided a charging device for a shaft furnace for processing granular materials said device comprising a first charging means provided with guide surfaces as hereinafter defined which charging means is adapted to charge a first granular material to an inner area of the furnace and one or more second charging means provided with said guide surfaces arranged to charge one or more granular materials of smaller particle size by gravity simultaneously to two or more locations in one or more outer areas close to the wall of said furnace, said guide surfaces of said charging means being adapted to remain stationary relative to each other during charging of the furnace.

According to another aspect of the present invention there is provided a method of charging a shaft furnace for processing granular material having a charging device which method comprises charging a first granular material to an inner area of the furnace and simultaneously and separately charging one or more materials of smaller particle size by gravity to two or more locations in one or more annular areas close to the wall of said furnace wherein during the simultaneous distribution of the materials to the different areas of the furnace, the components of the charging device within the furnace remain stationary.

The charging means in accordance with this invention are preferably in the form of chutes. In this case, the two types of charging means may be described as the "inner chute" and "outer chutes", respectively.

The furnaces with which the present invention is concerned need not necessarily be circular in cross-section, they may be elliptical or have other cross-sections, for example, rectangular, square or polygonal.

By the term "guide surfaces" as used herein is meant the surfaces of the charging means against which or on which the granular materials move whilst they are being charged to the furnace.

The invention can be applied both to choke feed furnaces as well as to furnaces in which the material fed to the furnace undergoes a free fall from the top of the furnace onto the top of the burden which is located some way down in the furnace.

Normally, it is sufficient to provide two chutes for charging material to the furnace, an inner chute and one outer chute around the inner chute. The inner chute need not necessarily deliver material to the inner area of the shaft. It may deliver material in a ring around the inner area and in such cases, the term "inner chute" is used to mean a chute which is surrounded by the outer annular chute or chutes. The inner chute will normally have an annular shape for example a circular, elliptical or polygonal shape in "free-fall" furnaces where the correct distribution of material charged through this chute will be obtained by arranging that the material bounces off a metal cone located within the duct defining the outer wall of the chute.

In general, the outer chute will be supplied with smaller granular material than the inner chute or chutes in order to increase resistance to gas flow near the wall of the furnace.

The charging device advantageously includes a screening mechanism which is preferably located near the top of the furnace and is arranged to supply material of a given range of grain sizes to the various chutes. Material to be charged to the furnace need not then be specially segregated but is merely transported to the top of the furnace in the same way as in previous charging devices which are in general use.

In a preferred arrangement of the present charging device for supplying a furnace in which the material charged undergoes a free fall on to the burden, the device contains no moving parts inside the furnace and the entry chutes are open to the atmosphere at all times. The top of the furnace is kept under suction so that air is drawn into the top of the furnace through the open chutes. The furnace exhaust gases are also removed by the suction mechanism and are discharged to the atmosphere through a chimney. The charging device is cooled by the air entering through it thus reducing the risk of the device deforming because of excessive heating up. It is important that the device should not deform if the material charged to the furnace is to be distributed in the desired pattern.

Specific embodiments of the invention will now be described by way of example with reference to the drawings accompanying the Provisional Specification in which:—

Figure 1 is a diagrammatic representation of a charging device according to the invention positioned on a choke feed kiln of elliptical cross-section;

Figure 2 is a horizontal section on the line II—II of Figure 1;

Figure 3 is a central vertical section through a preferred form of charging device according to the invention and having no moving parts;

Figure 4 is a horizontal section at the line IV—IV of the device shown in Figure 3, and

Figures 5 and 6 show diagrammatically the main parts of two further charging devices according to the invention. In both these cases the screen for sorting the feed to the kiln into two sizes of particles has been omitted from the Figures.

In all the drawings, only the top part of the shaft kiln has been shown.

Referring to Figures 1 and 2, a shaft kiln 1 has a burden 2. The upper surface of the kiln burden is shown at 2a. The kiln is provided with a duct 3 for removing the kiln gases. This duct is connected to an extractor fan (not shown).

An elliptical steel duct 4 divides the top of the kiln into an inner chute 6 and an outer chute 7 surrounding the chute 6.

A feed hopper 8 supplies granular feed material to a double deck screen 9 which divides the kiln feed into three fractions, namely, a large fraction which is fed to the inner chute 6 along the duct 10, a small fraction which is fed to the outer chute 7 along the ducts 11 and a fines or dust fraction which is rejected down a chute 12.

The ducts 11 are bifurcated and provide eight outlets for the granular material into the chute 7 (see Figure 2).

Referring now to Figures 3 and 4, a mixed feed dolomite kiln in accordance with the invention has a normal refractory lining 21 at its lower part but has a lining 22 of abrasion-resistant refractory bricks covering the top 6 ft. of the kiln. A steel "batter ring" 36 is provided on which the feed to the kiln impinges as it falls on to the burden maintained approximately at the level 23.

The kiln has a duct 24 into which the exhaust gases from the kiln are drawn. Some air is also drawn into the kiln through the duct 24. This helps to keep the feed device cool and to reduce risk of it distorting due to the heat.

A double deck screen 25 removes fine material by the chute 26, supplies large stone to an inner chute 28 through a duct 27, and supplies stone through bifurcated ducts 29 to an annular chute 30. The shaded portion in Figure 3 is dead space. An inverted steel cone 31 on a steel pipe 32 threaded at the top and supported by a nut 33 on a tube 34 is held in a framework 35 over the kiln. The position of the cone 31 can thus be adjusted.

The dimensions and angles of this device are chosen to give suitable stone distribution and burden profile in a mixed feed (coke and stone) doloma burning kiln. Final adjustment is obtained by altering the position of the cone 31.

Referring now to Figure 5, the refractory brick lining of the top of the kiln is shown at 41. A duct 42 leading to a chimney carries the exhaust gases from the kiln. A steel batter ring 43 is positioned under a charging bell 44 which can be moved up and down. The bell 44 is shown in the open (lower) position and stone from the hoppers 45 and 46 can fall into the kiln, the stone from the hopper 45 falling on to the cone 47. When the bell 44 is raised the cone 48 closes the central chute and the surrounding chute is also closed.

Figure 6 shows a similar charging device to that shown in Figure 5 but in which the batter ring 53 is mounted differently.

WHAT WE CLAIM IS:—

1. A charging device for a shaft furnace for processing granular material said device comprising a first charging means provided with guide surfaces as hereinbefore defined which charging means is adapted to charge a first granular material to an inner area of the furnace and one or more second charging means provided with said guide surfaces arranged to charge one or more granular materials of smaller particle size by gravity simultaneously to two or more locations in one or more outer areas close to the wall of said furnace, said guide surfaces of said charging means being adapted to remain stationary relative to each other during charging of the furnace.

2. A charging device as claimed in claim

1 wherein the said first charging means comprises a chute.

3. A charging device as claimed in claim 2 wherein the said one or more second charging means comprise one or more chutes disposed around the said first charging means.

4. A charging device as claimed in claim 3 wherein the said first charging means comprises an inner chute and the said second charging means comprises one or more chutes of annular cross-section disposed about the said inner chute and concentric with the said inner chute.

5. A charging device as claimed in any one of claims 2 to 4 wherein the said first charging means comprises an internal centrally disposed baffle adapted to deflect the falling granular material to an annular area of the surface of the furnace burden.

6. A charging device as claimed in any one of the preceding claims which includes a screening mechanism adapted to separate materials of a specific range of grain sizes from a mixture of such materials.

7. A charging device for a shaft furnace substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

8. A charging device for a shaft furnace substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

9. A charging device for a shaft furnace substantially as hereinbefore described with reference to Figures 5 or 6 of the accompanying drawings.

10. A shaft furnace whenever comprising a charging device as claimed in any one of the preceding claims.

11. A shaft furnace as claimed in claim 10 which is adapted to operate such that air is drawn into the furnace through the charging device.

12. A method of charging a shaft furnace for processing granular material having a charging device which method comprises charging a first granular material to an inner area of the furnace, and simultaneously and separately charging one or more materials of smaller particle size by gravity to two or more locations in one or more outer areas close to the wall of said furnace wherein, during the simultaneous distribution of the materials to the different areas of the furnace, the components of the charging device within the furnace remain stationary.

13. A method as claimed in claim 12 substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

14. A method as claimed in claim 12 substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

15. A method as claimed in claim 12 substantially as hereinbefore described with reference to Figures 5 or 6 of the accompanying drawings.

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1161872 PROVISIONAL SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

Fig. 1.

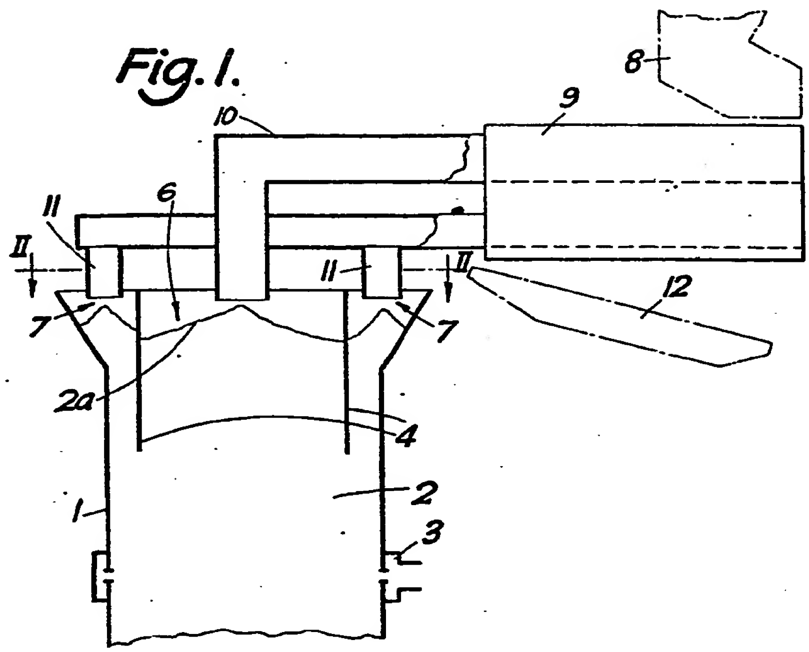


Fig. 2.

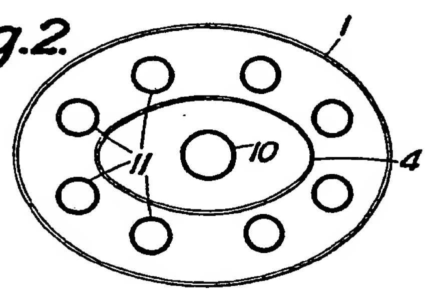
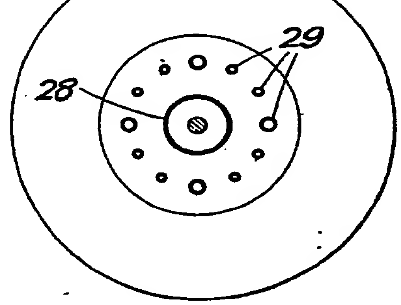


Fig. 4.



1161872 PROVISIONAL SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

Fig.3.

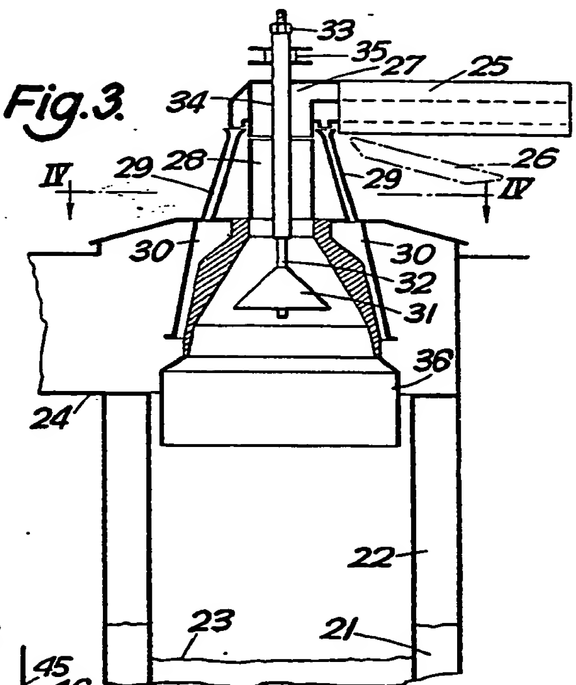


Fig.5.

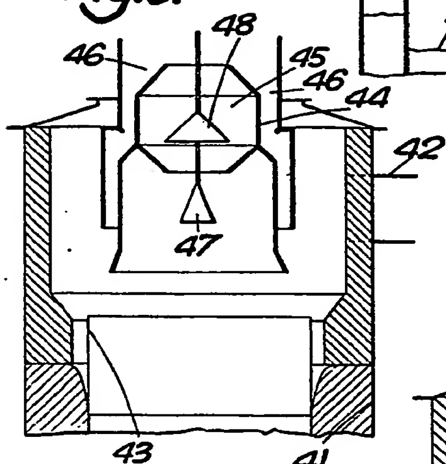


Fig.6.